Supplementary Appendices, Advance Directives and End-of-Life Medicare Expenditures

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1: Regression-Adjusted Medicare Spending by Type in the Last 6 Months of Life[a,b]

N = 3302	Treatment-Limiting Advance Directive Predicted Spending (95% CI)	No Limiting Directive Predicted Spending (95% CI)	Difference (95% CI)	P Value
Durable Medical				
Low-Spending Regions	$282 (190 to 374) n = 203	$361 (250 to 471) n = 251	-$79 (-220 to 62)	0.27
Medium-Spending Regions	$478 (387 to 569) n = 721	$518 (436 to 601) n = 1,126	-$40 (-169 to 89)	0.54
High-Spending Regions	$505 (377 to 633) n = 351	$867 (668 to 1066) n = 650	-$362 (-604 to -120)	0.003
Inpatient				
Low-Spending Regions	$10,672 (8954 to 12390) n = 203	$11,322 (8986 to 13658) n = 251	- $650 (-3546 to 2245)	0.66
Medium-Spending Regions	$13,386 (12112 to 14660) n = 721	$14,647 (13482 to 15812) n = 1,126	-$1,261 (-3063 to 540)	0.17
High-Spending Regions	$18,27 1 (15588 to 20955) n = 351	$25,780 (22689 to 28872) n = 650	-$7,509 (-11614 to -3404)	p < 0.001
Outpatient				
Low-Spending Regions	$4,778 (4048 to 5508) n = 203	$4,256 (3727 to 4784) n = 251	$522 (-386 to 1239)	0.26
Medium-Spending Regions	$5,867 (5386 to 6347) n = 721	$5,264 (4949 to 5582) n = 1,126	$603 (12.5 to 1193)	0.05
High-Spending Regions	$7,556 (6,606 to 8,506) n = 351	$7,578 (6991 to 8163) n = 650	-$20 (-1138 to 1097)	0.97

Skilled Nursing

Low-Spending Regions	$2,858 (1961 to 3754) n = 203	$2,212 (1602 to 2823) n = 251	$645 (-455 to 1746)	0.25
Medium-Spending Regions	$3,399 (2809 to 3990) n = 721	$2,607 (2272 to 2943) n = 1,126	$792 (82 to 1502)	0.03
High-Spending Regions	$4,095 (3250 to 4940) n = 351	$3,940 (3257 to 4623) n = 650	$154 (-973 to 1282)	0.79

Home Health

Low-Spending Regions	$645 (391 to 899) n = 203	$502 (315 to 689) n = 251	$143 (-176 to 462)	0.38
Medium-Spending Regions	$1,107 (908 to 1307) n = 721	$947 (800 to 1094) n = 1,126	$160 (-103 to 424)	0.23
High-Spending Regions	$1,433 (1073 to 1793) n = 351	$1,226 (1014 to 1439) n = 650	$207 (-223 to 637)	0.35

Hospice

Low-Spending Regions	$2,895 (1887 to 3902) n = 203	$1,836 (1181 to 2491) n = 251	$1058 (-158 to 2275)	0.09
Medium-Spending Regions	$2,579 (2087 to 3070) n = 721	$1,658 (1364 to 1952) n = 1,126	$921 (318 to 1523)	0.003
High-Spending Regions	$2,207 (1611 to 2802) n = 351	$1,231 (922 to 1539) n = 650	$976 (294 to 1658)	0.005

[a]Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports average predicted spending based on average marginal effects from a general linear model of Medicare spending on the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and chronic conditions prior to the last 6 months of life.

[b]Hospital referral regions classified using Dartmouth Atlas of Healthcare national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 2: Regression-Adjusted Total Medicare Spending by Inpatient Hospitalization Status in Last 6 Months of Life:[a]
Adjusted Association With Regional Spending Levels and Advanced Directive Use Amongst Decedents[b]

	Treatment-Limiting Advance Directive Predicted Spending (95% CI)	No Limiting Advance Directive Predicted Spending (95% CI)	Difference (95% CI)	*P* Value
Decedents With Hospitalization **N = 2,384**				
Low-Spending Regions	$27,071 (23728 to 30414) n = 140	$28,588 (24381 to 32796) n = 166	-$1,518 (-6908 to 3873)	0.58
Medium-Spending Regions	$32,339 (30227 to 34451) n = 512	$32,591 (30786 to 34396) n = 814	-$252 (-3176 to 2672)	0.87
High-Spending Regions	$41,494 (37081 to 45906) n =254	$48,546 (44310 to 52781) n = 498	-$7,052 (-13287 to -817)	0.03
Decedents Without Hospitalization **N = 918**				
Low-Spending Regions	$10,240 (7067 to 13413) n = 63	$10,166 (6987 to 13346) n = 95	$74 (-4520 to 4668)	0.98
Medium-Spending Regions	$10,663 (8708 to 12618) n = 208	$9,137 (7645 to 10628) n = 311	$1,526 (-1089 to 4141)	0.25
High-Spending Regions	$12,527 (9153 to 15900) n = 97	$10,169 (7124 to 13215) n = 152	$2,357 (-2393 to 7108)	0.33

[a]Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports average predicted spending (in $2007) based on average marginal effects from a general linear model of Medicare spending on the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and comorbidities.

[b]Hospital referral regions classified using Dartmouth Atlas of Healthcare national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 3: Regression Models of End-of-Life Expenditures and Treatments, General Linear Model and Logistic Regression Odds Ratios (Models used in Tables 3 and 4).

	Spending Coefficient, 95%CI	Hospice OR, 95% CI	In-Hospital Death OR, 95% CI	Life-Sustaining Treatment, OR, 95% CI
Treatment-Limiting Advance Directive	0.02 (-0.17,0.21)	1.08 (0.71,1.64)	1.18 (0.79,1.77)	1.25 (0.82,1.90)
Medium-Spending Region	0.6 (0.43,0.77)	0.55 (0.39,0.77)	1.71 (1.03,1.85)	1.40 (1.04,1.90)
High-Spending Region	0.19 (0.04,0.34)	0.65 (0.48,0.88)	1.38 (1.25,2.34)	1.74(1.24,2.42)
Limiting Directive* Medium Spending	-0.01 (-0.21,0.19)	1.61(1.02,2.55)	0.67 (0.43,1.04)	0.80 (0.51,1.28)
Limiting Directive* High Spending	-0.17 (-0.40,0.06)	2.16 (1.31,3.57)	0.55 (0.34,0.90)	0.7 (0.42,1.17)
DPOA Only	0.05 (-0.04,0.15)	1.3 (1.04,1.63)	0.84 (0.69,1.04)	1.06 (0.85,1.33)
Female	0.05 (-0.03,0.12)	1.19 (0.99,1.42)	0.96 (0.81,1.12)	1.04 (0.87,1.24)
Non-White	0.21 (0.11,0.31)	0.89 (0.69,1.15)	1.17 (0.95,1.45)	1.27(0.99,1.63)
Age less than 70	0.1 (-0.07,0.27)	0.62 (0.41,0.93)	1.1 (0.59,1.06)	1.14 (0.76,1.70)
Age 75 – 79	0.04 (-0.09,0.18)	0.77 (0.56,1.05)	1.08 (0.82,1.43)	1.04 (0.75,1.42)
Age 80 - 84	-0.02 (-0.14,0.11)	0.73 (0.54,0.99)	1.18 (0.90,1.54)	1.23(0.90,1.67)
Age 85 - 89	-0.06 (-0.19,0.07)	0.79 (0.58,1.07)	1.11 (0.84,1.47)	1.20 (0.88,1.65)
Age 90 and above	-0.29 (-0.43,-0.16)	1.02 (0.75,1.40)	0.79 (0.59,1.06)	0.80 (0.58,1.09)
Household Wealth $10,000 - $100,000	0 (-0.09,0.09)	1.27 (1.01,1.60)	0.97 (0.79,1.19)	1.06 (0.84,1.32)

Household Wealth Above $100,000	0.11 (0.01,0.22)	1.39 (1.10,1.75)	0.99 (0.80,1.22)	1.12 (0.89,1.41)
< High School	0.06 (-0.03,0.16)	1 (0.81,1.24)	1.08 (0.89,1.32)	1.22 (0.98,1.51)
High School Grad	0.03 (-0.07,0.12)	1.06 (0.86,1.31)	0.98 (0.81,1.19)	1.12 (0.89,1.36)
Separated/Divorced	-0.1 (-0.24,0.03)	0.71 (0.50,1.01)	1.02 (0.75,1.38)	0.84 (0.60,1.17)
Widowed/Single	-0.01 (-0.10,0.08)	0.87 (0.71,1.06)	1.06 (0.88,1.28)	0.96 (0.78,1.18)
Cancer	0.06 (-0.03,0.14)	1.52 (1.25,1.84)	0.87 (0.72,1.05)	1.07 (0.87,1.31)
Diabetes	0.11 (0.02,0.20)	0.87 (0.70,1.10)	1.19 (0.97,1.45)	1.41 (1.11,1.77)
Arthritis	0.09 (0.01,0.17)	0.86 (0.72,1.02)	1.18 (1.00,1.39)	1.0 (0.83,1.20)
Lung Disease	-0.08 (-0.17,0.01)	0.99 (0.68,0.96)	1.1 (0.91,1.34)	1.0 (0.80,1.25)
Heart Disease	0.01 (-0.06,0.09)	0.81 (0.68,0.96)	1.14 (0.98,1.33)	1.15 (0.97,1.36)
Stroke	0.02 (-0.07,0.11)	1.02 (0.83,1.26)	0.88 (0.72,1.07)	0.81 (0.66,1.00)
Mild Cognitive Impairment	-0.07 (-0.16,0.01)	1.04 (0.84,1.28)	0.97 (0.80,1.17)	1.03 (0.82,1.28)
Cognitive Impairment	-0.27 (-0.37,-0.17)	1.11 (0.89,1.38)	0.74 (0.61,0.91)	0.59 (0.48,0.74)

[a]Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports coefficients from a general linear model of Medicare spending and odds ratios from logistic regression of treatments on the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and comorbidities (Elixhauser comorbidities not shown for brevity).

[b]Hospital referral regions classified using Dartmouth Atlas of Healthcare national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 4: Medicare Spending in the Last 6 Months of Life: Adjusted Association with Regional Spending Levels and Advance Directive Use, Ordinary Least Squares Regression Coefficients[a,b]

	Coefficient (95% CI)
Treatment-Limiting Advance Directive	159 (-4295, 4614)
Medium-Spending Region	3,653 (-6, 7311)
High-Spending Region	17,354 (12459 - 22248)
Limiting Directive* Medium Spending	489 (-4268, 5247)
Limiting Directive* High Spending	-6,051 (-12591, -1490)
DPOA Only	1,627 (-1378, 4631)
Female	2,120 (-165.06, 4405.95)
Non-White	6,359 (2790.20, 9927.13)
Age less than 70	4,943 (-1161.41, 11046.34)
Age 75 – 79	1,984 (-2482.59, 6450.80)
Age 80 - 84	-118 (-4190.81, 3955.42)
Age 85 - 89	-2,249 (-6166.66, 1669.32)
Age 90 and above	-7,383 (-11530.94, -3235.19)
Household Wealth $10,000 - $100,000	-386 (-3167.27, 2395.76)
Household Wealth Above $100,000	2,675 (-454.35, 5803.83)
< High School	1,626 (-1142.63, 4394.27)

High School Grad	970 (-1909.52,3850.13)
Separated/Divorced	-1,819(-6270.25,2632.45)
Widowed/Single	-52 (-2862.10,2757.89)
Cancer	1.069 (-1593.35,3730.89)
Diabetes	2,353 (-734.35,5440.11)
Arthritis	1,849 (-489.43,4186.96)
Lung Disease	-2,349 (-5008.37,309.86)
Heart Disease	-13 (-2322.01,2295.69)
Stroke	764 (-1943.91,3471.10)
Mild Cognitive Impairment	-1,283(-4103.35,1538.16)
Cognitive Impairment	-7,140 (-9816.34,-4464.55)

[a]Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports coefficients from an OLS regression replicating the GLM specification in eTable 3.

[b]Hospital referral regions classified using Dartmouth Atlas of Healthcare national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 5: Regression-Adjusted Spending and Predicted Probability of Treatments in Last 6 Months of Life, Excluding Medicare Beneficiaries Under 65. (Compare to Tables 3 and 4 in Manuscript)[a,b]

Adjusted Association With Regional Spending Levels and Advanced Directive Use

	Treatment-Limiting Advance Directive $ or Probability (95% CI)	No Limiting Advance Directive $ or Probability (95% CI)	Difference (95% CI)	*P* Value
Predicted Spending, n = 3,214				
Low-Spending Regions	$21,619 (18863 to 24375) n = 196	$21,883 (18174 to 24193) n = 244	$435 (-3662 to 4533)	0.84
Medium-Spending Regions	$26,072 (24291 to 27853) n = 1,079	$26,002 (24467 to 23757) n = 713	$71 (-2433 to 2573)	0.96
High-Spending Regions	$33,701 (29001 to 37412) n = 347	$39,208 (35561 to 42854) n = 635	-$5,507 (-10809 to -205)	0.04
Any Hospice, n = 3,214				
Low-Spending Regions	38% (31 to 44) n = 196	36% (30 to 42) n = 244	1.6% (-7 to 11)	0.72
Medium-Spending Regions	38% (35 to 42) n = 1,079	27% (25 to 30) n = 713	11% (6 to 16)	p<0.001
High-Spending Regions	41% (36 to 46) n = 347	25% (21 to 28) n = 635	16% (10 to 23)	p<0.001
In-Hospital Death, n = 3,214				
Low-Spending Regions	38% (32 to 45) n = 196	35% (29 to 41) n = 244	3.4% (-6 to 13)	0.47
Medium-Spending Regions	37% (33 to 40) n = 1,079	42% (39 to 45) n = 713	-5.7% (-11 to -0.7)	0.02
High-Spending Regions	38% (32 to 43) n = 347	48% (44 to 52) n = 635	-10% (-17 to -3)	0.003
Lifesaving, n = 3,214				

Low-Spending Regions	29% (22 to 35) n = 196	28% (22 to 33) n = 244	1.1% (-7 to 10)	0.80
Medium-Spending Regions	36% (32 to 40) n = 1,079	37% (34 to 40) n = 713	-1.4% (-6 to 4)	0.59
High-Spending Regions	38% (33 to 44) n = 347	44% (40 to 48) n = 635	-5.4% (-12 to 1)	0.10

[a] Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports predicted spending based on average marginal effects from a general linear model of Medicare spending and predicted probabilities using marginal effects from logit models of treatment status as a function of the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and comorbidities.

[b] Hospital referral regions classified using national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 6: Regression-Adjusted Spending and Predicted Probability of Treatments in Last 6 Months of Life, Excluding Veterans. (Compare to Tables 3 and 4 in Manuscript)[a,b]

Adjusted Association With Regional Spending Levels and Advanced Directive Use

	Treatment-Limiting Advance Directive $ or Probability (95% CI)	No Limiting Advance Directive $ or Probability (95% CI)	Difference (95% CI)	*P* Value
Predicted Spending, n = 2,386				
Low-Spending Regions	$21,503 (18301 to 24705) n = 140	$21,278 (17770 to 24786) n = 179	$225 (-4547 to 4996)	0.93
Medium-Spending Regions	$26,099 (23954 to 28244) n = 495	$25,906 (24285 to 27527) n = 827	$193 (-2674 to 3059)	0.90
High-Spending Regions	$34,433 (30601 to 38265) n = 256	$40,512 (36155 to 44869) n = 489	-$6,079 (-12063 to -95)	0.046
Any Hospice, n = 2,386				
Low-Spending Regions	35% (27 to 43) n = 140	36% (29 to 42) n = 179	-0.5% (-11 to 10)	0.93
Medium-Spending Regions	39% (35 to 43) n = 495	28% (25 to 31) n = 827	11% (5 to 17)	p<0.001
High-Spending Regions	42% (36 to 48) n = 256	23% (20 to 27) n = 489	19% (12 to 26)	p<0.001
In-Hospital Death, n = 2,386				
Low-Spending Regions	40% (32 to 48) n = 140	34% (27 to 41) n = 179	5.6% (-5 to 16)	0.31
Medium-Spending Regions	34% (30 to 38) n = 495	43% (40 to 47) n = 827	-9% (-15 to -3)	0.002
High-Spending Regions	37% (31 to 43) n = 256	47% (43 to 52) n = 489	-10% (-18 to -3)	0.008

Lifesaving, n = 2,386

Low-Spending Regions	27% (20 to 35) n = 140	27% (20 to 33) n = 179	0.8% (-9 to 10)	0.87
Medium-Spending Regions	35% (30 to 39) n = 495	38% (35 to 41) n = 827	-3.2% (-9 to 2)	0.27
High-Spending Regions	39% (33 to 45) n = 256	44% (39 to 48) n = 489	-4.9% (-12 to 3)	0.20

[a] Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports predicted spending based on average marginal effects from a general linear model of Medicare spending and predicted probabilities using marginal effects from logit models of treatment status as a function of the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and comorbidities.

[b] Hospital referral regions classified using national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 7: Predicted Spending and Probability of Treatments in Last 6 Months of Life , Excluding Patients with Advanced Directives Written in the Last 6 Months of Life. (Compare to Tables 3 and 4 in Manuscript)[a,b]

Adjusted Association With Regional Spending Levels and Advanced Directive Use

	Treatment-Limiting Advance Directive Adjusted Results (95% CI)	No Limiting Advance Directive Adjusted Results (95% CI)	Difference (95% CI)	*P* Value
Predicted Spending, n=3,090				
Low-Spending Regions	$20,224 (17565 to 22883) n = 118	$20,874 (17834 to 23913) n = 162	-$649 (-4713 to 3414)	0.75
Medium-Spending Regions	$25,738 (23730 to 27746) n = 425	$25,895 (24374 to 27416) n = 796	-$157 (-2822 to 2508)	0.91
High-Spending Regions	$33,644 (29587 to 37701) n = 224	$39,366 (35720 to 43012) n = 493	-$5722 (-11269 to -175)	0.04
Any Hospice, n = 3,090				
Low-Spending Regions	36% (29 to 43) n = 118	35% (30 to 41) n = 162	1% (-8 to 10)	0.83
Medium-Spending Regions	36% (32 to 40) n = 425	27% (25 to 30) n = 796	9% (4 to 14)	0.001
High-Spending Regions	39% (34 to 45) n = 224	24% (21 to 28) n = 493	15% (8 to 21)	p<0.001
In-Hospital Death, n = 3,090				
Low-Spending Regions	39% (32 to 47) n = 118	35% (29 to 41) n = 162	4% (-5 to 14)	0.37
Medium-Spending Regions	37% (33 to 41) n = 425	42% (39 to 45) n = 796	-5% (-10 to 0.5)	0.08
High-Spending Regions	39% (33 to 44) n = 224	48% (44 to 51) n = 493	-9% (-16 to -2)	0.01
Lifesaving, n = 3,090				

Low-Spending Regions	31% (24 to 37) n = 118	28% (22 to 33) n = 162	3% (-6 to 12)	0.54
Medium-Spending Regions	35% (31 to 39) n = 425	37% (34 to 40) n = 796	-1% (-6 to 4)	0.58
High-Spending Regions	39% (33 to 44) n = 224	44% (40 to 48) n = 493	-5% (-12 to 1)	0.12

[a]Health and Retirement Study linked to Medicare claims, 1998 – 2007. The Table reports predicted spending based on average marginal effects from a general linear model of Medicare spending and predicted probabilities using marginal effects from logit models of treatment status as a function of the interaction between regional spending level and decedent advance directive status, sociodemographic characteristics and comorbidities.

[b]Hospital referral regions classified using national Medicare end-of-life spending data, 1999 – 2005. Low-spending HRRs averaged $8,787(range 7,252 - 9,707), medium-spending $10,848 (range 10,242 - 12,404), high-spending $15,744 (range 12,446 - $29,797) (unadjusted for inflation).

eTable 8: Characteristics of HRS-Medicare Linked Decedents Compared to all HRS Decedents, 1998 - 2007

	Medicare Linked HRS n = 4,761	All Eligible HRS n = 5,810	Difference (95% CI)
Female	52%	53.5%	-1.4% (-0.5% to 3%)
Non-White	15.3%	17.8%	-2.8% (-4% to -1%)
Years of Education	10.9 years	10.8 years	0.1 years (-0.24 to 0.04)